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ABSTRACT

The report states that teachers and administrators are in agreement as to the priorities and objectives in teaching elementary science. However, they strongly disagree regarding the obstacles to achieving effective science instruction. Mutual consensus is urged in this area to improve the science program. The study indicates that in-service programs are needed to provide new teaching procedures and that a long-range program needs to be designed to identify equipment needed, since inadequate equipment and facilities were termed, by teachers, as the major obstacles in science instruction. It is recommended that any new science programs adopted must include the equipment and materials that are an integral part of the program as well as in-service training. Consultants are recommended who would focus on desirable teaching behavior and make resources available. Finally, it is recommended that teachers be members of national and state science organizations as a method of becoming familiar with new programs and information. (BF)

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an EDC report:

Science Teaching in Pennsylvania Public Elementary Schools

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Science Teaching in Pennsylvania Public Elementary Schools: A Report

Presented by the Pennsylvania Science Teachers Association, Wilkes College

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Foreword

The Educational Development Center at Wilkes College is one of six such facilities established by the Pennsylvania Department of Education in order to pursue research and development activities which have statewide ramifications.

The Wilkes College Educational Development Center, with the cooperation of the Pennsylvania Science Teachers Association and the Pennsylvania Department of Education, conducted the present statewide survey to determine the status and direction of elementary public science education throughout the commonwealth.

Financed by the Pennsylvania Department of Education, the three-stage investigation represents the first formal comprehensive statewide study of the practices of elementary science teaching.

We acknowledge the assistance and support of the Coordinating Council of the Educational Development Center for their direction and the Bureau of Curriculum Services and the Bureau of Planning and Evaluation of the Pennsylvania Department of Education for assistance with on-site visitations and the collection of data. We also wish to thank the chief administrators, principals, and teachers who participated in the initial meeting, completed the survey questionnaire, or participated in the on-site visitations.

Specifically, we are most grateful to the project staff, all of whom gave generously of their time and without whom this study would not have been possible. Serving as project staff were:

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Finally, this report is dedicated and presented to all those teaching in elementary schools in Pennsylvania who have devoted and will continue to devote themselves to making the teaching of science a personally rewarding experience for each child coming within their realm of influence.

Joseph A. Skok, Director
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CHAPTER I

Introduction

BACKGROUND

The purpose of this report is to present information about public elementary school science in Pennsylvania. The thrust for the study was a lack of systematic base line data regarding the status of elementary science education across the commonwealth.

State law mandates "a planned course in science, including laboratory-type experiences, shall be taught in each year of the elementary school" (6). The very broadness of this state curriculum requirement permits considerable diversity in methods, content, time allotted, and procedures among and within the school districts of the state. Therefore, a study of the practices, policies, and status was undertaken in order to ascertain what was being done in elementary science education in Pennsylvania public schools.

The study considers the question:

> What must be done to install effective, pupil-centered programs in science that are:
> (a) reflective of the needs of children, and
> (b) within the province of local school districts consistent with staff and financial resources?

This question was explored in terms of recent trends in elementary science education, present elementary science curricular offerings, public attitudes toward science education, and the teaching and training characteristics of elementary science teachers.

The survey instrument was based on a questionnaire devised by Blackwood (2) for a comprehensive nationwide study of public elementary science teaching practices conducted by the United States Office of Education in 1961-62.

In the ten years that have elapsed since the Blackwood report, a whole new era of elementary science curriculum reform has transpired. One outgrowth of this reform movement is the national science curricula which since have been implemented in many school systems across the

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nation. Although there is some diversity among the national curricula in terms of content and structure, they are characterized by certain common elements. They all emphasize the active participation of students, the teacher as guide and director rather than lecturer, and the use of manipulative materials in place of textbooks. The newer science curricula tend to involve more mathematics and have a greater balance between development of the process skills and the accumulation of science content. The national science curricula have their foundations in the behavioral sciences and were developed cooperatively by scientists and educators through testing and refinement in the elementary classroom situation (3).

National curricula referred to in the study are:

> Science--A Process Approach (SAPA) which emphasizes the development of skills in 13 processes through exercises organized hierarchically to provide proper sequencing of activities (5).
>
> Elementary Science Study (ESS) which consists of over 50 science units which emphasize the child's involvement with physical materials and may be sequenced with flexibility (4).
>
> Science Curriculum Improvement Study (SCIS) which is a sequential program organized around science concepts representing the physical and biological sciences (7).
>
> Minnesota Mathematics and Science Teaching (MINNEMAST) which presents a unified mathematics and science curriculum organized sequentially so that students will gain competence in observing, measuring, experimenting, generalizing, and deducing (1).

PROCEDURES

The three phase study was begun in the fall of 1971. Phase I consisted of a two-day conference held at State College, Pennsylvania. Twenty-five randomly selected school districts throughout Pennsylvania were each represented by one elementary teacher and one principal. Through individual interviews and group discussions, participants were requested to (a) discuss their perceptions of the status of elementary science education in Pennsylvania; (b) analyze critically the status quo

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they described; and (c) present suggestions for the improvement of elementary science in the commonwealth. A summary of major conference recommendations is incorporated in Appendix B.

In Phase II, a twenty percent sample of all public elementary schools in Pennsylvania was randomly selected from a list compiled by the Pennsylvania Department of Education. An elementary school is defined as kindergarten or grade 1 through grade 6, or a school approved as an elementary school by the Secretary of the Department of Education (6). Structured questionnaires to be completed by both the principal and an elementary school teacher were sent to 542 schools. The responses to the questionnaire were indicative of the individual school. However, the nature of certain questions required the data representing the responses of the teachers to be treated separately from the data representing the responses of the principals. Four hundred thirty-four questionnaires were returned--an 80 percent rate of response.

Phase III consisted of on-site visits to randomly selected elementary schools to acquire first hand information for the purpose of corroborating the findings of the Phase II survey. Results of the survey were recorded on data processing cards and analyzed by standard computer techniques.

The findings were largely in the form of descriptive statistics for the purpose of establishing base line data. Product moment, point biserial, and fourfold correlations were calculated where indicated.

The study does not make inferences about causal relationships, nor does it presume to evaluate current practices in elementary science. Tests of significance were computed where appropriate.

This survey is limited by the procedures employed in the study, the degree to which the findings can be generalized, the validity of the respondent's answers to the questionnaire, and the flood of 1972 which destroyed certain raw data reserves and postponed the completion of this report.

OVERVIEW

Chapter II of the study includes selected information presented in an informal question-and-answer format. Chapter III is devoted to an analysis and brief discussion of the statistical findings of the survey. Chapter IV includes implications and considerations of a general nature based upon the study in terms of present recommendations of the Pennsylvania Department of Education for the teaching of elementary school science, and recognized national trends in elementary school science.

Appendix A is composed of tables presented as they are discussed in the text. Appendix B is a portion of the interim report summarizing the recommendations put forth in Phase I of the study.

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CHAPTER II

Questions and Answers

In this chapter, selected information from the survey was used to describe the teachers, the science program, and the school in a question-and-answer format. The questions that follow were not stated in their present form in the questionnaire but are those most frequently asked by elementary teachers regarding science instruction.

THE TEACHERS

Q. Why Teach Science?

A. The answers of both elementary school teachers and principals to this question were inferred from the way they arranged a list of ten priorities for the teaching of elementary science. A surprising result was that teachers and administrators were in almost perfect agreement as to the way these objectives should be ranked. Stated another way, teachers and principals appear to hold the same purposes for the teaching of science, and they seem to place the highest priority upon developing critical thinking skills, curiosity, and problem-solving abilities among elementary students.

It is interesting to note that teachers and administrators ranked "developing hobbies", "preparing for high school science", and "developing scientists" lowest in importance. This suggests that elementary school educators do not believe they should determine their science teaching values according to secondary school standards or for development of future scientific skills. Instead, general student intellectual skills are expressed as their main concern.

The ten objectives presented in the questionnaire were arranged in the following identical order (hierarchy of importance) by both teachers and principals:

1. Develop critical thinking
2. Develop curiosity
3. Develop problem-solving skills
4. Develop attitudes about the environment
5. Develop concepts for interpreting the environment
6. Develop the use of science for the betterment of man
7. Teach knowledge about typical science areas (e.g., plant life, animal life, weather)

8. Develop hobbies
9. Prepare for high school science
10. Develop scientists

OBSTACLES TO THE TEACHING OF SCIENCE

Q. What do teachers consider to be the main obstacles to the teaching of science?

A. The answer to this question is based upon the way teachers ranked a list of thirteen selected factors that described obstacles to the teaching of science. The ranking of these obstacles reveals what teachers feel are the greatest handicaps in science teaching since these choices are ranked near the top of the list. Similarly, the factors teachers believe to have relatively little effect in science instruction are ranked nearer the end of the list. The teachers' ranking is shown below:

1. Lack in-service facilities
2. Inadequate room facilities
3. Lack of supplies and equipment
4. Insufficient funds to purchase equipment and supplies
5. Lack of adequate consultants
6. Curriculum not sufficiently determined
7. Not enough time to teach science
8. Insufficient knowledge of science teaching methods
9. Insufficient science knowledge
10. Inability to improvise materials and equipment
11. School believes science less important than other areas
12. Lack of teacher interest
13. Lack of community support

One of the most important and revealing findings of this ranking was the difference between the teachers' ranking of the obstacles and the administrators' ranking of these same obstacles. The discrepancies observed in this comparison of teacher-administrator ranking suggest insight into what may be one of the greatest factors constraining the improvement of the teaching of science--disagreement among teachers and administrators concerning obstacles to the teaching of science. It is one thing to agree on what science teaching should develop among students (ranking of elementary science teaching priorities) and quite another thing to disagree as to what is preventing this development among students. Wherever there is difference of opinion between teachers and administrators on this listing, conflict can be expected to occur in their dealings over these

matters. The administrators' ranking of these obstacles is given below:

1. Insufficient knowledge of science teaching methods
2. Insufficient science knowledge
3. Lack in-service facilities
4. Lack of adequate consultants
5. Inadequate room facilities
6. Lack of teacher interest
7. Not enough time to teach science
8. Lack of supplies and equipment
9. Curriculum not sufficiently determined
10. Inability to improvise materials and equipment
11. Insufficient funds to purchase equipment and supplies
12. School believes science less important than other areas
13. Lack of community support

The following are the discrepancies in teacher-administrator rankings that proved to be statistically significant. It is apparent that administrators focus on teachers (insufficient knowledge of science, methods, and lack of interest) as the main obstacles to elementary school science instruction while teachers disagree with this view and, instead, indicate matters of in-service, room facilities, supplies, equipment, and insufficient funds as the major obstacles.

TABLE 1

Comparison of Teacher and Administrator Rankings of Obstacles to Effective Science Teaching

	Teacher Ranking	Administrator Ranking
Lack in-service facilities	1	3
Inadequate room facilities	2	5
Lack of supplies and equipment	3	8*
Insufficient funds to purchase equipment and supplies	4	11**
Lack of adequate consultants	5	4
Curriculum not sufficiently determined	6	9
Not enough time to teach science	7	7
Insufficient knowledge of science teaching methods	8	1**
Insufficient science knowledge	9	2**
Inability to improvise materials and equipment	10	10
School believes science less important than other areas	11	12
Lack of teacher interest	12	6**
Lack of community support	13	13

* ϵ .05
** ϵ .01

It can be inferred that teachers and administrators are clearly and significantly in disagreement where the difference in their statement rankings is statistically significant.

Q. What opportunities do teachers have for in-service science education at schools surveyed?

A. Over half of the teachers surveyed report opportunities for in-service science education in each of the following areas: teachers' meetings, curriculum development, workshops. It should be noted, however, that the content, quality, and effectiveness of these workshops were not considered in the survey.

Q. How many teachers surveyed have attended in-service science workshops?

A. Forty-six percent of the teachers surveyed have attended in-service science education workshops whereas fifty-four percent have not.

The data did not determine the recency nor the nature of the in-service workshop attended by the teacher.

Teacher Satisfaction with Science Teaching

Q. Are teachers generally satisfied with the way they are teaching science? How determined?

A. One-third of the teachers surveyed were satisfied with the way they were teaching science, but two-thirds were dissatisfied. Some of the factors associated with teacher dissatisfaction are: inadequate room facilities, lack of supplies and equipment, lack of adequate consultants, lack of in-service training, and a curriculum that is not sufficiently determined.

Teacher Interest in Teaching Science

Q. Why do some elementary teachers show a lack of interest in teaching science?

A. Teachers tend not to be interested in teaching science when the school in general believes science is less important, when there is a lack of time, in-service training, or when the curriculum is not sufficiently determined.

Sources of Information About New Science Programs

Q. How do educators find out about new science programs?

A. Over sixty percent of both teachers and administrators indicate that they find out about new science programs through mail brochures. The second most common source of information is the school principal, followed by teacher committees, conventions, the science supervisor, and the department head. This suggests that advertising has a strong influence in decision making, along with principals' concepts. The difference in teacher-administrator view of the obstacles to science teaching assumes obvious importance at this point.

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Availability of Consultant Help

Q. Is there consultant help in teaching science available within the school system?

A. Forty percent of the teachers have access to consultant help while sixty percent lack the assistance of a consultant. Earlier studies also showed elementary teachers had very little consultant assistance (41.8 percent) even though they said they needed this help at that time (2).

THE SCIENCE PROGRAM

Instructional Strategies

Q. What approaches to teaching science are being utilized?

A. Thirty-eight percent of teachers surveyed described their science program as textbook oriented. Thirty-five percent reported using an activity-oriented program, while twenty-two percent used a combination of approaches, and five percent utilized a demonstration-oriented program.

Textbooks and Textbook-Oriented Science Programs

Q. Are textbooks widely used in teaching elementary science?

A. More than half of the teachers surveyed used one textbook. Over one-third used multi-texts. About one-eighth used no text at all.

Q. Do textbook-oriented science curricula tend to encourage an activity approach to teaching?

A. Not according to the survey. Where teachers <u>did</u> describe their program as predominantly textbook-oriented, they described their program as <u>not</u> being activity oriented, but based on one textbook. Furthermore, they indicated that equipment was lacking.

Where respondents characterized their program as being activity oriented, they typically responded that they did not use a text. They also felt a lack of science supplies and equipment.

Teachers trained in a national program also responded that they typically did not use a textbook, nor were they oriented toward a textbook.

National Science Curricula (Science--A Process Approach, etc.)

Q. To what extent are national science curricula used in elementary school districts in Pennsylvania?

A. Thirty percent of educators surveyed utilize a national science program in their schools. The following percentages indicate the number of administrators surveyed that noted at least one classroom in their school using the following national curricula:

Science--A Process Approach (SAPA) - Nineteen percent

Science Curriculum Improvement Study (SCIS) - Twelve percent

Elementary Science Study (ESS) - Fourteen percent

Minnesota Mathematics and Science Teaching Project (MINNEMAST) - One percent

(N. B. Administrators in some cases indicated that more than one program is being used in their school.)

This data should be viewed as an approximation of the percent of actual use of these programs since a typical "yes" answer can mean a single classroom or an entire school is using the materials. The degree of a program's usage is always difficult to determine accurately. The best that can be expected is to reveal general trends of usage and to answer large questions such as how widespread or how limited is the use of certain programs. It is safe to say from the above data that national programs are in use in Pennsylvania schools, but to a limited degree. They are certainly not widely used at the present time even though they have been available over the last ten years or so.

Q. Are teachers receiving training in the use of national curricula?

A. Among all the schools in the survey the percent of teachers trained in national curricula through in-service was 24.4 percent, summer institutes -- 15 percent, consultants -- 14.4 percent, or by some other means was 10 percent. These figures show all the training of the teachers in national programs through the above activities regardless of whether or not those teachers are using the programs in their classroom.

Where teachers are using a national program in their classroom, it seems they generally received training in a national program. A direct, significant, and positive correlation was found ($r=.647$) between the use

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of a national curriculum in a school and teachers in the school having been trained in national programs.

Science Fairs and Science Oriented Field Trips

Q. Do classes participate in science fairs or exhibits?

A. Only one-fifth of teachers queried reported class participation in science fairs or exhibits.

Q. Do students go on science-oriented trips?

A. Over half (51 percent) of the teachers surveyed reported that their classes have taken a science-oriented field trip.

THE SCHOOL

Departmentalization of Science

Q. Is science taught as a part of the teacher's regular teaching duties?

A. Seventy-eight percent of teachers surveyed teach science as a part of their regular teaching duties, while twenty-two percent are special science teachers. The vast majority of elementary teachers teach science and other subjects.

Where departmentalization does occur, it is limited in grades one (2.3 percent), two (2.5 percent), and three (4.8 percent). There is an escalation of departmentalization to over 20 percent (22.5 percent) in grade four, which increases to 38.1 percent and 39.8 percent for grades five and six, respectively. Generally, science is taught in nondepartmentalized classrooms for the majority of elementary students at all grade levels. Departmentalization, when it occurs, is usually found in the intermediate elementary school grades.

Q. In what grades do children go to a special room for science?

A. Until they are in fourth grade, only a very small percentage (less than 3 percent) of students in the schools surveyed go to a special room for science. Fourteen percent of fourth grade students and one-quarter of fifth and sixth graders have science in a special room. For the most part, students studying science in a special room may be expected to study science in a departmentalized setting. This cannot be determined by the data, however.

Size of Elementary Science Classes

Q. How large is the average class in elementary science?

A. There are 27 students in the average elementary science class. The number may range between 23 and 31. Generally, the size of a science class is the same as any other subject class size.

Q. How much time is spent per week on the teaching of science?

A. The time per week described as allotted to science ranges from 30 to 300 minutes. The average time per week is 166 minutes according to the survey. The amount of time spent teaching science in the primary grades is generally less than the time spent teaching science in the intermediate grades. This difference is neither apparent nor documented by the data although it was discussed during on-site visits by the survey staff.

Availability of Equipment and Supplies

Q. To what extent are equipment and supplies for science demonstrations and experiments available?

A. Teachers surveyed report equipment and supplies for science demonstrations and experiments in their schools as being:

Plentiful - 12 percent
Adequate - 55 percent
Inadequate - 27 percent
Lacking - 6 percent

Thus, twelve percent of the teachers describe their equipment and supplies as plentiful while thirty-three percent of the teachers say they have insufficient equipment and supplies.

These figures are general and for all teachers surveyed. An examination of the relationship between the program used by the teacher and the availability of equipment and supplies provides additional insight. For example, teachers using national programs in elementary science felt that equipment and supplies were available and that they did have adequate room facilities, supplies, equipment, and funds. On the other hand, teachers describing their program as predominately textbook oriented or non-activity oriented felt they lacked supplies and equipment.

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Responsibility for Ordering Science Equipment

Q. Who orders science equipment?

A. The majority of teachers order their own equipment. Next likely to be responsible for ordering equipment is the principal, followed by a teacher committee or the elementary supervisor.

Least likely to order science equipment is the department chairman or the science supervisor.

It is interesting to note that although teachers are mainly responsible for ordering their own science equipment, only 12 percent of all teachers consider their science equipment plentiful. The rest rate their equipment somewhere between adequate and lacking. Either teachers do not order science equipment or their requests for equipment are turned down. On-site visits frequently lend support to the former explanation.

Adoption of Science Textbooks and Materials

Q. How are science textbooks or materials adopted?

A. In most schools (82.5 percent), science textbooks and materials are adopted by a teachers' committee. The school principal, central office, or others adopt materials and books in schools where this is not a function of a teachers' committee.

A logical conclusion to draw from this data is a direct choice of teachers--both science curricula and materials. The data, however, do not explain whether teachers' committees are given total control over their choice of materials or whether they follow the guidance or direction of the administrative staff in the schools. The answer may lie somewhere between these two positions.

Nevertheless, teachers presently have the potential for a majority voice in establishing priorities for the adoption of science curricula and supplies.

Availability of Science Materials Centers

Q. To what extent are science materials centers available?

A. Over three-quarters of all educators surveyed have a science materials center in their district. However, the science materials

center referred to may be anything from a supply closet to a well-equipped materials center serving the entire district.

Grading Systems in Science

Q. Do schools present alternative choices to a traditional grading system?

A. Ten percent of Pennsylvania schools do not give children a regular grade in science. Schools with national science curricula tend not to use traditional grading procedures whereas schools using a single text approach do tend tc give sc.ence grades.

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CHAPTER III

Analysis and Discussion of Data

This chapter is devoted to presenting in a technical and more complete manner the survey data regarding the practices of science teaching in the schools surveyed. Included are an analysis of the objectives for teaching science, the obstacles to effective science teaching, teacher attitudes, dissemination of information, science in the curriculum, the role of textbooks, national science curricula, departmentalization, and resources.

OBJECTIVES FOR TEACHING SCIENCE

Pennsylvania principals and teachers are in accord as to the priorities in teaching elementary science. Both groups emphasize the importance of developing the students' capacity for critical thinking, curiosity, and problem solving. The educators rate developing hobbies, preparing for high school science, and developing scientists as objectives with lowest priority. It is interesting to note the many similarities between the ranking of these objectives by the Pennsylvania respondents and those sampled by Blackwood in his national survey of elementary science 1961-62. The two surveys diverge most dramatically in the switching of the third and sixth ranked items. Blackwood's group ranked third--teach knowledge of typical science areas, and sixth--develop problem-solving skills. The Pennsylvania sample appears to show a greater appreciation for the importance of process (problem-solving skills) and seems to de-emphasize content (knowledge about typical areas) as opposed to Blackwood's sample (2).

OBSTACLES TO EFFECTIVE SCIENCE TEACHING

As stated before there are no significant differences between the rankings by Pennsylvania teachers and principals regarding objectives for teaching science. However, there are significant differences between the perceptions of these two groups of educators in ranking five of thirteen obstacles to effective science teaching.

Principals feel that the teachers' insufficient knowledge of science teaching methods and content are the greatest barriers to effective science teaching. Furthermore, they indicate that a lack of teacher interest, ranked sixth, is of significantly greater importance to effective science teaching than do teachers, who rank it twelfth.

Teachers, on the other hand, select a lack of in-service and room facilities as the most important barriers, and differ significantly with principals regarding the lack of supplies and equipment and insufficient funds with which to purchase these.

The two groups agree in their ranking of not enough time to teach science (ranked seventh) and inability to improvise materials and equipment (ranked tenth). In addition, both teachers and principals regard a lack of community support as the least important barrier to effective science teaching (see Table 1).

Obstacles were not described individually as barriers to effective science teaching. Instead, they were perceived as interrelated and described together in various combinations throughout the survey. For example, a school which has inadequate room facilities also lacks supplies and equipment ($r = .849^{**}$), sufficient funds ($r = .597^{**}$), enough consultants ($r = .459^{**}$), sufficient time to teach science ($r = .330^{**}$), adequate in-service training ($r = .459^{**}$), a curriculum that is sufficiently determined ($r = .285^{**}$).

Educators surveyed associated inadequate room facilities with the school's belief that science is less important ($r = .257^{*}$) and a lack of community support ($r = .199^{*}$).

TEACHER ATTITUDES

There are twice as many teachers dissatisfied (66.9 percent) as there are teachers who are satisfied (33.1 percent) with the way they are teaching science. In the course of on-site visitations when teachers were asked why they taught science the way they did, most answered that they taught the only way they knew how. Other factors interfering with teacher satisfaction are: a lack of supplies and equipment ($r = -.290^{**}$), inadequate room facilities ($r = .252^{*}$), lack of adequate consultants ($r = -.299^{**}$), and a curriculum which is not sufficiently determined ($r = -.214$).

Of the first six obstacles ranked by teachers as interfering with effective science teaching, five of these six factors correlated significantly with teacher dissatisfaction. It appears that the same problems that interfere with effective teaching also cause teachers to be dissatisfied with their work.

* $p < .05$
** $p < .01$

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Based on their teaching experience during the school year of the survey, 70.8 percent of the teachers responded that they feel eager about teaching science. There is a positive relationship between teachers who feel eager about teaching science and those who are satisfied with the way they are teaching science ($r = .205^{**}$).

Teachers tend to lack interest in teaching science if they are teaching in schools which consider science less important than other subjects ($r = -.617^{**}$) and do not provide adequate in-service training ($r = -.508^{**}$), enough time for science ($r = .534^{**}$), or a curriculum that is sufficiently determined ($r = .323^{**}$).

DISSEMINATION OF INFORMATION

New Programs

Teachers and principals indicated ways in which they find out about new science programs. Mail brochures are described as the most common source of information--61.2 percent of all educators learned of new programs this way. The principal was a source of information for 51.3 percent of respondents and teachers' committees supplied information to 25.7 percent. Sixteen and one-half percent indicate the science supervisor, 15.8 percent--conventions, and 8.9 percent--the department head as disseminators of information about new science programs.

Teachers go to the science supervisor (34 percent), the principal (26.4 percent), the high school teacher (15.4 percent), or another teacher (15.4 percent), or the department head (8.8 percent) for information regarding science concepts.

Consultant Help

There is consultant help in teaching science available within the school system for 40.1 percent of the teachers. The consultant help is generally a high school teacher or science supervisor. There is no consultant help available for 59.9 percent of the teachers.

Over half of the teachers indicate opportunities for in-service education: 55.9 percent had access to teachers' meetings, 57.6 percent to curriculum development, and 50.6 percent to workshops. Of teachers

* $p < .05$
** $p < .01$

surveyed, 46.3 percent attend in-service science workshops. Thus, it would appear that when in-service science workshops are available, most teachers attend them.

A lack of adequate consultants is significantly related to lack of in-service education ($r = .795^{**}$) and a curriculum that is not sufficiently determined ($r = .525^{**}$). Where the consultant help is inadequate, teachers are neither eager about teaching science ($r = -.260^{**}$) nor satisfied with the way in which they are teaching science ($r = -.299^{**}$). Educators surveyed tend to believe consultants are not provided when the school believes science is less important than other subjects ($r = .201^{*}$).

SCIENCE IN THE CURRICULUM

All elementary schools surveyed report that science is being taught in their schools. While the average time per week allotted to science is 165.9 minutes, the amount of time ranges from 30 minutes to 300 minutes. The average science class lasts 38.9 minutes; 14.1 percent of teachers teach double science periods or blocks.

Sixty percent of the respondents indicated that they were using a locally developed curriculum guide. Of these, 37.3 percent were developed by the district and 23.2 percent were developed by the individual district.

Thirty-seven percent of the respondents indicated that, on occasion, they combined science and social studies.

A lack of appropriate mathematical skills and concepts causes problems in teaching science for 22.4 percent of teachers. The higher the grade level taught, the greater the number of teachers who perceived mathematics deficiencies as causing difficulty.

THE ROLE OF TEXTBOOKS

The textbook continues to be a widely used teaching tool. The majority of teachers rely upon a single text (52.8 percent), while 34.3 percent use more than one text. Only 12.9 percent of teachers surveyed use no text.

* $p < .05$
** $p < .01$

A program described as "textbook oriented" is likely to be based on a single textbook ($r = .360^{**}$) and involve a non-activity approach to teaching science ($r = -.644^{**}$).

Four of the five factors ranked by teachers as presenting the greatest obstacles to effective science teaching correlated significantly with a textbook-oriented program. These are: a lack of supplies and equipment ($r = .350^{**}$), insufficient funds to purchase supplies and equipment ($r = .206^{*}$), a shortage of adequate consultants ($r = .200^{*}$), and a lack of in-service training opportunities ($r = .250^{*}$). In addition, a textbook-oriented program shows a significant relationship with the obstacle ranked second by principals, which was that teachers possess insufficient science knowledge ($r = .210^{*}$).

NATIONAL SCIENCE CURRICULA

There is a national science curriculum program in at least one class in 30 percent of all the Pennsylvania elementary schools surveyed. In some cases, the national curriculum has been implemented in all the science classes throughout the school. In some instances, the program is being used: (1) only in classes at the primary grade level, or (2) in one or more classes that are pilot projects, or (3) in conjunction with a second national science curriculum in the school or schools administered by the principal responding to the questionnaire.

The largest number of principals whose schools use a national curriculum utilize Science--A Process Approach (19 percent). Fourteen percent have at least one class that uses Elementary School Science and twelve percent use Science Curriculum Improvement Study. Only one percent employ the Minnesota Mathematics and Science Teaching Project.

A school implementing one of the national science curricula tends to have an activity-oriented program ($r = .383^{**}$) rather than a textbook-oriented program ($r = -.330^{**}$) and may use no text at all ($r = -.303^{**}$). Furthermore, the school is less likely to give children a regular science grade ($r = -.291^{**}$), teach about typical science areas ($r = -.246^{*}$), or have insufficient funds ($r = -.204^{*}$).

Where schools have implemented a national science curriculum, they usually provide training for teachers using the national program ($r = .647^{**}$).

The larger the size of the school enrollment, the more likely that it will have teachers trained in a national program ($r = .256^{*}$).

* $p < .05$
** $p < .01$

Teachers trained in a national program tend to belong to a state or national science teachers organization (r= .229*). They also advocate an activity-oriented program (r= .339**) without a textbook (r= .286**) rather than a textbook-oriented program (r= -.316**) utilizing one text (r= -.172*).

Teachers trained in a national curriculum are likely to have adequate consultants (r= .237*), sufficient funds to purchase equipment and supplies (r= .237*), and enough supplies and equipment (r= .246*).

DEPARTMENTALIZATION

The majority of schools report that science is being taught by teachers who teach science as part of their general teaching responsibilities. Seventy-eight percent of the teachers surveyed are regular classroom teachers, whereas twenty-two percent are special teachers of science.

Regular classroom teachers do not tend to belong to a national or state science teachers organization (r=-.233*). Teachers who teach science as part of their regular teaching duties are likely to have difficulty improvising (r= .199*).

Schools use departmentalization for science teaching to a greater extent in the upper elementary grades although the percent of teachers teaching in departmentalized classrooms does not exceed 40 percent at any grade level.

* $p < .05$

** $p < .01$

TABLE 2

Grades in Which Departmentalization is Used

in the Teaching of Science

in Pennsylvania Public Elementary Schools 1971-72

Grade	Number of Schools	Percentage of Schools
K - Yes	6	1.40
No	434	98.60
1 - Yes	10	2.30
No	430	97.70
2 - Yes	11	2.50
No	429	97.50
3- Yes	21	4.80
No	419	95.20
4 - Yes	99	22.50
No	341	77.50
5 - Yes	167	38.10
No	271	61.90
6 - Yes	174	39.80
No	263	60.20

Most children do not go to a special room for science; however, in schools where they do, it is likely that a special room will be provided in the upper elementary grades.

TABLE 3

Grades in Which Children
Go to a Special Room for Science
in Pennsylvania Public Elementary Schools 1971-72

Grade	Total	Percentage
K - Yes	2	.50
No	436	99.50
1 - Yes	7	1.60
No	431	98.40
2 - Yes	10	2.30
No	428	97.70
3 - Yes	12	2.70
No	426	97.30
4 - Yes	63	14.40
No	375	85.60
5 - Yes	105	24.00
No	333	76.00
6 - Yes	111	25.30
No	327	74.70

RESOURCES

Seventy-six percent of school districts have a science materials center.

Ordering of Science Equipment

The majority of teachers (55 percent) order their own science equipment. Some respondents indicated that more than one person or group orders science equipment at their school. They indicate that the principal (34.9 percent), a teacher committee (28.2 percent), the elementary supervisor (20.6 percent), the science supervisor (10.8 percent), and the department chairman (5.7 percent) also order science equipment.

Availability of Equipment and Supplies

Two-thirds of the teachers have equipment and supplies available for science demonstrations and experiments; 11.9 percent had plentiful and 54.5 percent had adequate science equipment and supplies. One-third of the teachers do not have adequate science supplies and equipment; 27.3 percent said that science equipment and supplies are inadequate while 6.3 percent state that they are lacking.

Difficulty with the Use of Science Equipment

Only 5.8 percent of teachers report difficulty operating or assembling any of the science equipment at their school. Teachers who emphasize the teaching of typical areas are not likely to have problems using science equipment ($r = -.219^{*}$). However, a "typical areas" approach may involve the use of less equipment than other methods of elementary science teaching.

Sources from Which Science Materials are Borrowed

Teachers often depend upon a high school science teacher when they need to borrow science materials. The science supervisor and the principal also represent sources from which science materials can be borrowed. Table 4 lists the percentage of responses and the sources from whom equipment is borrowed.

* $p < .05$
** $p < .01$

TABLE 4

Where Teachers Go to Borrow Science Materials
in Pennsylvania Public Elementary Schools 1971-72

	Number of Responses	Percentage of Responses
Principal	42	18.80
Science Supervisor	43	19.30
Department Head	18	8.10
Other Teacher	39	17.50
High School Teacher	80	35.90
Janitor	1	.40

Sources of Help in Repairing Science Equipment

When teachers need to have science equipment repaired, they are likely to seek someone who is within the building (almost one-half seek the principal, one-eighth the janitor) or readily accessible (over one-fifth ask the science supervisor, one-eighth a high school teacher). It is interesting to note that respondents rarely ask a fellow teacher or their department chairman for help in equipment repair. Information concerning sources of help in repairing science equipment is cited in Table 5.

TABLE 5

Where Teachers Go to Repair Science Equipment
in Pennsylvania Public Elementary Schools 1971-72

	Number of Responses	Percentage of Responses
Principal	75	42.90
Science Supervisor	39	22.30
Department Head	9	5.10
Other Teacher	8	4.60
High School Teacher	21	12.00
Janitor	23	13.10

Audio-Visual Aids

The results of the questionnaire reveal that schools generally have a large variety and adequate quanities of audio-visual teaching aids.

Motion pictures are in sufficient quantities in 80 p/rcent of the schools. Fortunately, 92 percent of schools also have adequate or plentiful projectors with which to show these films. This is not the case with slides. While 82.6 percent of schools have enough slide projectors, only 44.7 percent have sufficient slides.

Both software and hardware are widely available in filmstrips (79.8 percent) and their projectors (93.6 percent) but much less available in film loops (22.4 percent) and film loop projectors (32.2 percent).

Television is available to 70 percent of the schools, but radio (33.8 percent) is less widespread. Tape players and recorders (79.5 percent) are more readily available than are cassette players and cassettes (48.1 percent). Slightly more than half of the schools (52.5 percent) have sufficient study prints, while slightly less than half (45.7 percent) have enough models.

Class activity kits are reported to be plentiful in 11.6 percent of schools and adequate in 34.4 percent. However, 30.7 percent have inadequate amounts, and 23.3 percent are lacking class activity kits. Information about audio-visual teaching aids are in Table 6.

TABLE 6

Extent to Which Audio-Visual Materials and Equipment are Available for Science Teaching in Pennsylvania Public Elementary Schools 1971-72

Audio-Visual Aids	Number of Schools	Percentage of Schools
Moving Pictures		
Plentiful	114	26.60
Adequate	230	53.70
Inadequate	62	14.50
Lacking	22	5.10
Slides		
Plentiful	44	10.50
Adequate	144	34.20
Inadequate	131	31.10
Lacking	102	24.20
Filmstrips		
Plentiful	124	28.50
Adequate	223	51.30
Inadequate	82	18.90
Lacking	6	1.40
Film Loops		
Plentiful	18	4.50
Adequate	71	17.90
Inadequate	108	27.30
Lacking	199	50.30
Television		
Plentiful	100	23.60
Adequate	202	47.60
Inadequate	67	15.80
Lacking	55	13.80
Radio		
Plentiful	22	5.60
Adequate	111	28.20
Inadequate	79	20.10
Lacking	182	46.20
Moving Picture Projectors		
Plentiful	110	25.30
Adequate	290	66.70
Inadequate	33	7.60
Lacking	2	.50

TABLE 6 (Continued)

Audio-Visual Aids	Number of Schools	Percentage of Schools
Slide Projectors		
Plentiful	89	20.90
Adequate	263	61.70
Inadequate	41	9.60
Lacking	33	7.70
Filmstrip Projectors		
Plentiful	118	27.30
Adequate	287	66.30
Inadequate	25	5.80
Lacking	3	.70
Film Loop Projectors		
Plentiful	18	4.60
Adequate	109	27.60
Inadequate	77	19.50
Lacking	191	48.40
Tape Players and Recorders		
Plentiful	87	20.20
Adequate	255	59.30
Inadequate	74	17.20
Lacking	14	3.30
Cassette Players and Recorders		
Plentiful	68	15.90
Adequate	181	42.20
Inadequate	95	22.10
Lacking	85	19.80
Study Prints		
Plentiful	50	11.80
Adequate	171	40.40
Inadequate	125	29.60
Lacking	77	18.20
Models		
Plentiful	24	5.60
Adequate	171	40.10
Inadequate	140	32.90
Lacking	91	21.40
Class Activity Kits		
Plentiful	49	11.60
Adequate	146	34.40
Inadequate	130	30.70
Lacking	99	23.30

CHAPTER IV

Implications and Considerations

According to this survey, inadequacies exist in Pennsylvania elementary school science programs. Although some schools have well-developed science programs, the value of this survey will be determined by suggestions about ways to help all schools, but most particularly those with inadequate programs.

The following considerations grow out of the data and conclusions of the survey, the printed statistical information and the personal interactions among all who participated.

ELEMENTARY SCHOOL TEACHERS AND ADMINISTRATORS NEED CONTINUALLY TO INTERACT ABOUT THE PURPOSE AND AREAS OF CONFLICT IN SCIENCE INSTRUCTION. Teachers and principals agree as to the purpose of science instruction; however, they disagree strongly regarding the obstacles to achieving effective science instruction. The effective science instruction they both describe cannot be achieved until there is agreement as to what the obstacles actually are and how to go about removing them. Improvement of elementary science instruction will depend on their mutual effort and consensus in the process of investigating and improving the science program.

SCHOOLS NEED TO DESIGN AND/OR PARTICIPATE IN IN-SERVICE PROGRAMS CONCERNED WITH IMPROVING SCIENCE TEACHING METHODS. Pennsylvania elementary school educators are concerned with teaching science to develop critical thinking, curiosity, and problem-solving skills. Further, teachers dissatisfied with their science instruction indicate that they know of no other teaching procedures and they feel their present curriculum is not sufficiently determined. In-service programs in science, therefore, need to include:

1. Identification of critical thinking and problem-solving behavior of students.

2. Development and use of student activities to improve the above.

3. Examination of existing curricula for science that are complete, oriented toward student activities, tested in classrooms, and adaptable to the entire elementary school program.

SCHOOLS, SCHOOL DISTRICTS, AND INDIVILUAL TEACHERS NEED TO IDENTIFY SCIENCE EQUIPMENT AND FACILITY NEEDS AND DESIGN A LONG-RANGE PROGRAM TO SATISFY THOSE NEEDS. Teachers perceive equipment and facility needs as major obstacles in science teaching. Many respondents described their equipment and facilities as inadequate or lacking. Further, inadequate facilities and supplies were statistically related to teacher dissatisfaction. More effort needs to be expended in obtaining supplies for all elementary classrooms, to encourage student activities, and to remove what teachers perceive as a major obstacle to effective science teaching. The plans should extend over a period of years and become a continuous procedure.

IMPLEMENT NEW SCIENCE PROGRAMS ONLY AFTER THEY HAVE BEEN EXAMINED CAREFULLY AND PLANS HAVE BEEN APPROVED TO PROVIDE THE EQUIPMENT AND MATERIALS THAT ARE AN INTEGRAL PART OF THE PROGRAM. Teacher training in the use of national programs, teacher satisfaction, and availability of equipment and resources were all positively related in the data. The importance of establishing programs designed to involve student activity underlines the need to prepare teachers to accept and use such new programs and materials. Where national programs were in use in Pennsylvania schools, teacher satisfaction was noted and teacher training and resources were provided. All activity-centered programs required teacher in-service and support with appropriate resources.

SCHOOLS SHOULD IDENTIFY CONSULTANTS TO HELP WITH THE ELEMENTARY SCIENCE PROGRAM AND PROVIDE RESOURCES FOR USE OF THE CONSULTANTS. Lack of consultative assistance noted in Blackwood's earlier study (2) continues to be a problem. Consultative assistance should provide for improvement of elementary science instruction through a constant focus on desirable teaching behavior and resources for this purpose. Teachers should have this assistance readily available to them.

ENCOURAGE ELEMENTARY TEACHER MEMBERSHIP IN NATIONAL AND STATE SCIENCE ORGANIZATIONS. Sixty percent of the respondents in the survey indicated that they learned about new programs through commercial brochures received in the mail. The effectiveness of such information is often a function of the ingenuity of the advertising agency. The journals of state and national science organizations present new programs and information in a form readily adaptable to the classroom, and similar information can also be obtained from attendance at the meetings of these organizations.

Appendix A

TABLES

TABLE 7

Mean Ranks, Standard Deviations, and t-Ratios
for Teachers and Administrators
on the Objectives for Teaching Science

Ranked According to Importance

Objectives for Teaching Science	Teachers N=82		Administrators N = 82		
	Mean Ranks	Standard Deviation	Mean Ranks	Standard Deviation	t-ratio
1. Develop critical thinking	3.32	2.11	3.26	2.00	.181
2. Develop curiosity	3.34	2.47	3.43	2.45	-.095
3. Develop problem-solving skills	3.66	1.74	3.54	2.10	.388
4. Develop attitudes about the environment	3.83	1.79	3.77	1.88	.113
5. Develop concepts for interpreting the environment	3.90	1.77	3.81	1.87	.323
6. Develop the use of science for the betterment of man	4.90	2.45	4.61	2.48	.760
7. Teach knowledge about typical science areas	6.13	2.00	6.00	2.25	.395
8. Develop hobbies	8.06	1.56	7.93	1.27	.587
9. Prepare for high school science	8.33	1.40	8.59	1.46	-1.17
10. Develop scientists	9.32	1.02	9.32	1.03	-.016

TABLE 8

Mean Ranks, Standard Deviations, and t-Ratios
for Teachers and Administrators
on the Factors that Present Difficulty
in Accomplishing Effective Science Teaching

Factors That Present Difficulty in Accomplishing Effective Science Teaching	Teachers N=82		Administrators N = 82		
	Mean Ranks	Standard Deviation	Mean Ranks	Standard Deviations	t-Ratio
Inadequate room facilities	5.78	3.91	6.43	3.82	-1.09
Lack of supplies and equipment	5.83	3.89	7.01	3.62	-1.98*
Insufficient funds to purchase experimental supplies	5.95	3.56	8.10	3.45	-3.85**
Lack of community support	9.81	3.28	10.28	2.69	-1.00
Inability to improvise materials and equipment	7.74	3.25	7.12	3.20	1.23
Insufficient science knowledge	7.45	3.40	5.13	3.05	4.53**
Insufficient knowledge of science teaching methods	6.98	3.45	4.88	3.21	3.97**
Lack of adequate consultants	6.19	3.49	6.38	3.23	-.34
Lack of teacher interest	8.52	3.93	6.59	3.73	3.17**
Curriculum not sufficiently determined	6.71	3.44	7.08	3.65	-.66
School believes science less important than other areas	7.95	3.67	8.71	3.49	-1.31
Not enough time to teach science	6.66	4.33	6.79	3.58	-.21
Lack of in-service training	5.52	3.03	5.57	3.16	-.12

* $p < .05$
** $p < .01$

TABLE 9

Opportunities Teachers Have
for In-service Science Education
in Pennsylvania Public Elementary Schools 1971 - 72

Type of In-service Science Education	Number of Teacher Responses	Percentage of Teacher Responses
Teachers Meetings		
Yes	95	55.90
No	75	44.10
Curriculum Development		
Yes	99	57.60
No	73	42.40
Workshops		
Yes	88	50.60
No	86	49.40

TABLE 10

How Teachers Find Out About New Science Programs
in Pennsylvania Public Elementary Schools 1971-72

Resources	Number of Responses	Percentage of Responses
Principal	214	51.30
Science Supervisor	69	16.50
Department Head	37	8.90
Conventions	66	15.80
Mail Brochures	255	61.20
Teachers' Committee	107	25.70

Note: Teachers received their information from more than one source.

TABLE 11

Nature of the Science Programs Used
in Pennsylvania Public Elementary Schools 1971 - 72

	Number of Schools	Percentage of Schools
Textbook Oriented	67	38.10
Activity Oriented	62	35.20
Demonstration Oriented	9	5.10
Combination of Above	38	21.60

TABLE 12

Methods Used in Training Teachers
for National Science Curricula
in Pennsylvania Public Elementary Schools 1971-72

Method	Number of Teachers	Percentage of Teachers
In-service Workshops		
Yes	135	30.80
No	304	69.20
Summer Institutes		
Yes	83	18.90
No	356	81.10
Consultants		
Yes	66	15.10
No	372	84.90
Other		
Yes	50	11.40
No	388	88.60

TABLE 13

Extent to Which Equipment and Supplies
for Science Demonstrations and Experiments are Available
in Pennsylvania Public Elementary Schools 1971-72

Availability	Number of Responses	Percentage of Responses
Plentiful	21	11.90
Adequate	96	54.50
Inadequate	48	27.30
Lacking	11	6.30

TABLE 14

Where Teachers Go
for Information Regarding Science Concepts
in Pennsylvania Public Elementary Schools 1971 - 72

	Number of Responses	Percentage of Responses
Principal	55	25.60
Science Supervisor	64	29.70
Department Head	20	9.30
Other Teacher	41	19.10
High School Teacher	35	16.30
Janitor	0	0.0

TABLE 15

Elementary School Organization Patterns
of Pennsylvania Public Elementary Schools 1971 - 72

Grade Grouping	Number of Schools	Percentage of Schools
K-4	17	4.00
K-5	48	11.20
K-6	262	64.30
K-8	4	.90
1-4	8	1.90
1-5	10	2.30
1-6	63	14.70
1-8	3	.70

Appendix B

INTERIM REPORT, PHASE I,
Pennsylvania Science Survey

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The major activity in Phase I consisted of group meetings of teachers and principals. One teacher and one principal from approximately twenty-five randomly selected Pennsylvania school districts attended a two-day meeting held in State College, Pennsylvania. Those people were asked to: (1) describe their perception of the present state of science education in the commonwealth, (2) critique the situation, and (3) make recommendations for improving elementary science programs. This report summarizes the discussion that transpired and presents a synthesis of the consensus of the total group.

Five groups of participants met concurrently in four three-hour sittings. One group was made up entirely of principals, one group was solely teachers, and the three remaining groups included both principals and teachers. Each group was assigned a person with some expertise in science education and group dynamics to act as a facilitator to interaction of participants. Newsprint pads (18" x 24") and magic markers were supplied so that a record of ideas discussed would be visible to all participants during the meeting and available for analysis at the end. These data served as the bases for reports submitted by facilitators which in turn became the data used in this report.

Without exception, the teachers and principals who attended this meeting were dedicated to the success of their mission. From the beginning, group facilitators were impressed with the willingness of participants to become totally involved in the discussions and to make contributions. Their concern for improving the educational system, as evidenced by their enthusiasm, warrants that their views be considered. To this end the following major group recommendations have been generalized.

1. Science should not be strictly compartmentalized. It should be integrated with other subject matter areas; it should be humanized. The relationship between science and other academic areas, and the relationship between science and life, should not be left to chance. Correlative recommendations include the need:
   a. for field trips and greater use of resource people (one group felt this was not done sufficiently);
   b. to integrate mathematics, art, etc., with science;
   c. to encourage use of scientific behavior in learning outside of science;
   d. for greater utilization of school environment and immediate surroundings as a source of learning activities;
   e. for inclusion of special interest materials, hobbies, and enrichment-oriented games which are related to science;
   f. to include health and engineering--applications of science.

One group suggested that the ideal science programs would be focused on issues and problems in real life themes.

2. The key to the success of any program is the teacher. This was stated explicitly by the principals, is implicit in all aspects of this report, and seems intuitively obvious. Supportive of the statement are the following concerns expressed in the discussions:

a. The successful implementation of a new program will include provisions of time to teachers for purposes of planning -- e.g., acquiring materials, organizing procedures--learning new content, inventing adjustments in order to provide for individual differences.

b. In-service training (the principals felt after school in-service was unrealistic) and assistance should be continuous. Workshops, interaction with teachers from other districts (removes local schools from isolated behavior focus), and availability of expert consultants were mentioned.

c. One group pointed out that no program is implemented in the same way in all schools. Ultimately, the teachers will be required to make adjustments in order to meet the needs of his students.

d. Teacher attitudes must be consistent with the program. Contemporary science programs call for redefinition of the role of the teacher. He becomes a decision maker in the learning process and manager or coordinator of experiences as opposed to a purveyor of information.

3. Implementation of a new program is more apt to be successful if someone is prepared to provide leadership to a team effort--the team including both teachers and communicative administrators. All groups expressed a need for an outside consultant and/or an in-house supervisor with the specific charge to provide continuing assistance, direction, and coordination of efforts. He should be an idea resource person but not a materials resource person (this was believed to be an aide's job). Finally, the consultant or supervisor, whichever, should be responsible for evaluation of the program and its installation, BUT NOT RESPONSIBLE FOR THE EVALUATION OF THE TEACHER. Neighboring colleges were cited as sources of help for school programs.

4. In an elementary school science program students should be actively involved in experiences, particularly those which permit manipulation of concrete materials, which are designed to develop skill in science as a process. From the reports of meetings it would appear that all participants supported this general recommendation.

Some specific recommendations include the design and establishment of:

a. child-centered rather than teacher-centered or subject-matter-centered programs;
b. activity-oriented programs;
c. programs designed to make science fun and get kids actively involved;
d. creativity-oriented programs in which open-ended inquiry should be emphasized;
e. programs designed to develop cognitive skills;
f. programs involving problem solving and critical thinking.

5. Adequate facilities and time for planning are essential to successful installation of a new science program. One group suggested the necessity for (a) classroom laboratories, (b) science centers, and (c) an outdoor site. Most groups recommended providing aides for clerical duties, accumulating and preparing materials, and for working with small groups.

6. No consensus was reached regarding self-contained classrooms or departmentalization. One group felt that team teaching or a modified departmentalized program is necessary to the structure of an acceptable science program. Another group recommended self-contained primary grades and departmentalized intermediate grades. The group of principals reached no consensus.

7. The creation of a state center for science should be considered. Only one group suggested this, probably because someone in that group was familiar with the Tennessee Central Science Center. This center would:

a. disseminate information;
b. conduct workshops and in-service programs;
c. provide consultants, facilities, etc.

8. Science objectives should be stated behaviorally.

9. No grades should be given in elementary science.

10. Communication in science is important. Students should be involved in reporting, demonstrating, and discussing topics.

11. School-directed outside experiences (e.g., field trips) should be used more extensively. Children need to interact with their environment.

12. Provisions for continued involvement of the program should be built in at the outset of the program installation.

*It would be impossible at this point to describe what type of science program generally exists in the schools. The questionnaire in Phase II should yield substantive data about the kinds of programs that may be found in the commonwealth. From the discussions, it would appear that programs range from structured, textbook programs to locally developed activity-oriented programs to nationally developed curricula (e.g., ESS, SAPA, and SCIS). It was suggested by one group that rural school districts tend to be anti-innovation and favor a traditional textbook orientation, while urban and suburban districts tend to incorporate the national programs to a greater degree.

In conclusion, the activities of Phase I have yielded recommendations for improving science education in Pennsylvania. Although highly subjective in nature, these recommendations are somewhat representative of the feeling of teachers and principals. The extent to which these statements are valid will be determined during Phase II and III of the project.

*Editors Note: Phase I preceded the survey information described earlier in Chapters I, II, III and IV.

Appendix C

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8. Science for the Seventies

Appendix D

PARTICIPATING SCHOOL DISTRICTS

Abington Heights SD
Abington SD
Ahmic Area SD
Allegheny-Clarion Valley SD
Allegheny Twsp. SD
[illegible] Area SD
[illegible]ville Comm SD
Annville-Cleona SD
Armstrong SD
Ash Point SD
Athens Area SD
Avon Grove Elementary
Avonworth SD
Baldwin-Whitehall District
Bangor Area SD
Bellwood SD
Bald Eagle Area SD
Bedford Area SD
Bethlehem Area SD
Bethel Park SD
Bentworth SD
Berwick Area SD
Big [illegible] Area SD
Bellefonte Area SD
Belle Vernon Area SD
Bellwood-Antis SD
Boyertown Area SD
Bradford Area SD
Bristol Township SD
Brookville Area SD
Brownsville Area SD
Butler Area SD
Camp Hill SD
Canadohta County SD
Carlynton SD
California Area SD
Carlisle Area SD
Centennial Schools
Central Dauphin SD
Central Cambria SD
Central York SD
Centennial SD
Chartiers Valley SD
Chichester SD
Chambersburg Area SD
Charleroi SD
Cheltenham SD
Clearfield Area Schools
Clarion-Limestone Area SD
Curwensville Area SD
Connellsville Area SD
Conrad Weiser Area SD
Colonial SD
Conemaugh Valley SD
Coatesville Area SD
Cocalico SD
Council Rock SD
Conewago Valley SD
Conestoga Valley SD
Cornwall-Lebanon Schools
Cumberland Area SD
Columbia Boro. SD
Corry Area SD
Crestwood Central SD
Curwensville Area SD
Cumberland Valley SD
Dallas SD
Dallastown Area SD
Danville Area SD
Derry Township SD
Devon School
Delaware Valley SD
District #7 SD
District #1 SD
Downingtown Area SD
Donegal SD
Dunmore Boro. SD
Dubois Area SD
E. Allegheny SD
East Penn SD
Easton Area SD
East Pennsboro Area SD
Eastern Lebanon Co. SD
East Lycoming School
Eastern Lancaster County SD
Edgewood SD
Ellwood City Area Schools
Elizabeth Forward SD
Elizabethtown Area SD
Ephrata Area SD
Everett Area SD
Exeter Township SD
Farrell Area SD
Ferndale Area SD
Forest Area SD
Forest Hills SD
Fort Cherry SD
Fox Chapel Area SD
Fort Le Boeuf SD
Fraxinus Schools
Freedom Area SD
Franklin Area SD
Gateway SD
Gettysburg Area SD
Gen McLane Joint SD
Gen. Clymer School
Glendale SD
Governor Mifflin SD
Gr. Johnstown SD
Grove City Area SD
Greenville Area Schools
Greater Nanticoke Area SD
Greencastle-Antrim SD
Greater Johnstown SD
Greenwood SD
Hanover Public SD
Hazleton Area SD
Hampton Township SD
Harbor Creek Township SD
Harrisburg SD
Hatboro-Horsham SD
Hatfield SD
Haverford Township SD
Hamburg Area SD
Hanover Area SD
Highlands SD
Hickory Township SD
Hollidaysburg Area SD
Indiana Area SD
Interboro Joint SD
Jersey Shore Area District
Kane Area SD
Keystone Oaks SD
Keyston Central SD
Kennett Consolidated SD
Kutztown Area SD
Lampeter-Strasburg SD
Lake Lehman SD
Lan City SD
Laurel Highlands SD
Lamview SD
Lewisburg Area SD
Lehighton Area SD
Lewisburg Area SD
Line Mountain SD
Lower Merion SD
Lower Merion Twp. SD
Loyalsock Twp. SD
Manheim Twp. SD
Manheim Central SD
Marple Newton SD
Mars Area SD
McKeesport SD
Mechanicsburg Area SD
Millcreek Twp. SD
Millcreek School
Millersburg SD
Mid- [illegible]nty SD
Millville Area SD
Milton Area SD
Mountain View SD
Muhlenberg Boro. SD
Monroeville Area SD
Mohawk Area SD
Montrose Area SD
Mt. Pleasant Area SD
Mahanoy Twp. SD
Nazareth Area SD
Northampton SD
New Brighton Area Schools
New Castle Area SD
Indian Providence Twp. SD
Northern York Co. SD
Northern Lebanon SD
Northern Potter SD
North Pocono SD
North Allegheny Schools
Norristown Area SD
Northampton Area SD
North Penn SD
Northwestern Lehigh SD
Northwestern SD
North Schuylkill SD
Northwest Area SD
North Clarion SD
Northwestern SD
Northern Lehigh SD
North Hills SD
Northern Tioga SD
Octorara Area District
Oxford Area SD
Palmyra Area SD
Palisades SD
Panther Valley SD
Penns Valley Area SD
Pennsbury SD
Penncrest SD
Pennridge SD
Peters Township SD
Pen Argyl Area SD
Penns Manor Area Alverda Elem. School
Pittsburgh
Phila-Upton SD
Phoenixville Area SD
Pittsburgh Public Schools
Pittsburgh Board of Public Ed.
Pittsburgh City SD
Pittsburgh Area SD
Plum Boro. SD
Pottstown SD
Pottsville Area SD
Pocono Mt. SD
Port Allegany SD
Portage Area SD
Punxsutawney Area SD
Quakertown Community SD
Quaker Valley SD
Radnor Twp. Schools
Redbank Valley SD
Reading SD
Reynolds SD
Red Lion Area School
Ridley SD
Riverside SD
Ringgold SD
Richland SD
Rochester Area SD
Sayre Area SD
Salisbury Twp. SD
SD of Lancaster
Scranton SD
Scranton City SD
School District of Phila.
Schuylkill Haven Area SD
Selinsgrove Area SD
Sharon City SD
Shippensburg Area SD
Shamokin Area SD
Sharpsville Area SD
Shenango Area SD
Shikellamy SD
Smethport SD
Southern Tioga SD
Southern Fulton SD
Southern Huntingdon Co. SD
Southeastern Greene SD
South Western SD
Socke SD
Solanco SD
Southeast Butler Co. SD
South Eastern York Co. SD
Southern Lehigh SD
South Butler Co. SD
Spring Ford Area SD
Springfield Twp. SD
Stroudsburg Area SD
St. Mary's Area SD
State College Area Schools
Ste Rte SD
Sullivan County Elem. School
Susquehanna Community SD
Susquehanna Twp. SD
Tamaqua Area SD
Tri-Valley Area SD
Trinity Area SD
Tunkhannock SD
Tussey Mountain SD
Twin Valley SD
Tyrone Area SD
Titusville Area SD
Union City Area SD
Uniontown Area SD
Unionville Chadds Ford SD
Upper Adams SD
Upper Dauphin Elem. SD
Upper Perkiomen SD
Upper Merion Area SD
Upper Darby SD
Upper St. Clair Twp. SD
Upper Dublin SD
Wayne Highlands SD
Warren County Schools
Washington SD
Waynesboro North SD
Wallenpaupack Area SD
West Shore SD
West Allegheny SD
West York SD
West Shore SD
Wellsboro Area SD
West Chester Area SD
West Jefferson Hills SD
West York Area SD
West Mifflin SD
Whitehall Coplay SD
Wilkes-Barre Area SD
Williamsport Area SD
Wilmington Area SD
Wilkinsburg SD
Wilson Area SD
Wissahickon SD
Wilson SD
Williams Valley SD
Wyomissing Area SD
Wyoming Valley West SD
Yeadon SD
York City SD

BEST COPY AVAILABLE